

IN THE CLAIMS

Please amend the claims as follows:

Claim 1 (Currently Amended): An exposure method to transfer a pattern of a mask illuminated with exposure light from a light source onto a substrate through an optical system, said method comprising:

setting a time interval for measurement of a transmittance of said optical system;
setting an exposure condition for transferring said pattern of said mask onto said substrate;

changing said time interval for measurement in consideration of a transmittance of said optical system that changes depending on said set exposure condition;

~~changing said time interval for measurement in accordance with an exposure condition for transferring said pattern of said mask onto said substrate;~~

measuring a transmittance of said optical system at said changed time interval for measurement;

setting an exposure amount control target value in accordance with said measured transmittance of said optical system; and

transferring said pattern onto said substrate through said optical system, while an exposure amount is controlled based on a photodetection result of a part of said exposure light photodetected between said light source and said mask and said set exposure amount control target value.

Claims 2-3 (Cancelled).

Claim 4 (Previously Presented): An exposure method according to Claim 1, wherein said exposure condition includes a transmittance of said mask.

Claim 5 (Previously Presented): An exposure method according to Claim 1, wherein said exposure condition includes one of a minimum line width of said pattern and a permissible exposure amount error.

Claims 6-13 (Cancelled).

Claim 14 (Currently Amended): An exposure method to illuminate a mask with exposure light from a light source and transfer a pattern of the mask onto a substrate through an optical system, said method comprising:

setting time intervals for measurement in respect to at least two exposure conditions for transferring said pattern of said mask onto said substrate, each of said time intervals for measurement being different from one another, in consideration of a transmittance of said optical system that changes depending on each of the at least two exposure conditions;

setting one exposure condition of said at least two exposure conditions; and measuring the an amount of said exposure light which passes through said optical system and reaches onto said substrate at said time interval for measurement that corresponds to said set exposure condition.

Claim 15 (Previously Presented): An exposure method according to Claim 14, wherein said two exposure conditions include at least one of an illumination condition to illuminate a mask, a transmittance of said mask, a minimum line width, and a permissible exposure amount error.

Claim 16 (Currently Amended): An exposure method to transfer a pattern illuminated with exposure light from a light source onto a substrate through an optical system, said method comprising:

~~measuring a variation in the performing a first measurement of an amount of said exposure light passing through said optical system at a predetermined time interval for measurement; and~~

~~changing said time interval for measurement in accordance with a comparison result of a variation of a first measurement of said light amount and a variation of a second measurement of said light amount~~

performing a second measurement of an amount of said exposure light passing through said optical system at a predetermined time interval after said first measurement of the amount of said exposure light;

comparing the amount of said exposure light obtained by said first measurement and the amount of said exposure light obtained by said second measurement; and

obtaining a time interval for measurement for measuring an amount of said exposure light passing through said optical system in third and succeeding measurements, in accordance with the comparison result.

Claim 17 (Original): An exposure method according to Claim 16, wherein said first and second measurements are performed prior to starting of exposure.

Claim 18 (Original): An exposure method according to Claim 16, wherein said first and second measurements are performed after starting of exposure.

Claim 19 (Original): An exposure method performed by an exposure apparatus to transfer a pattern illuminated from a light source with exposure light through an optical system onto a substrate, said method comprising:

a self-cleaning to clean said optical system by irradiating said optical system with said exposure light on a predetermined condition prior to exposure;

a prediction function determining to determine a transmittance time-varying prediction function of said optical system in consideration of said predetermined condition; and

setting said exposure amount control target value based on said determined transmittance time-varying prediction function.

Claim 20 (Original): An exposure method according to Claim 19, wherein said prediction function determining takes into consideration a period of time in which the operation of said apparatus is stopped.

Claim 21 (Original): An exposure method according to Claim 19, wherein said predetermined condition includes an irradiation time of said exposure light on said optical system, said exposure light intensity, and an irradiation amount.

Claim 22 (Cancelled).

Claim 23 (Previously Presented): An exposure method according to Claim 14, further comprising:

obtaining a transmittance of said optical system in accordance with an amount of said exposure light which is measured before passing through said optical system, and said measurement result of said exposure light passing through said optical system.

Claim 24 (Currently Amended): An exposure apparatus to transfer a pattern illuminated with exposure light from a light source onto a substrate, said exposure apparatus comprising:

a branch optical system arranged in an optical path of said exposure light to branch a part of said exposure light;

an optical system arranged between said branch optical system and said substrate;

a transmittance measurement unit to measure a transmittance of said optical system at a predetermined time interval;

a control unit connected with said transmittance measurement unit to change said time interval in accordance with in consideration of a transmittance of said optical system that changes depending on an exposure condition for transferring said pattern onto said substrate;

an exposure amount setting unit connected with said transmittance measurement unit to set an exposure amount control target value in accordance with a transmittance of said optical system that is measured by said transmittance measurement unit at said changed time interval; and

an exposure amount control system connected with said exposure amount setting unit to control an exposure amount based on said set exposure amount control target value.

Claims 25-27 (Cancelled).

Claim 28 (Previously Presented): An exposure apparatus according to Claim 24, further comprising:

an information reading unit to read information of a mask on which the pattern is formed, and

said control unit automatically determines time intervals for measurement of said transmittance measurement unit based on said information of said mask read by said information reading unit.

Claim 29 (Currently Amended): An exposure apparatus to transfer a pattern illuminated with exposure light from a light source onto a substrate, said exposure apparatus comprising:

a branch optical system arranged in an optical path of said exposure light to branch a part of said exposure light;

an optical system arranged between said branch optical system and said substrate;

a transmittance measurement unit to measure a transmittance of said optical system;

a control unit connected with said transmittance measurement unit to compare a transmittance obtained by a most recent measurement and a transmittance obtained by a measurement performed before said most recent measurement, and set a time interval for transmittance measurement of said transmittance measurement unit in accordance with the comparison result a variation amount between a transmittance obtained by a most recent transmittance measurement and a transmittance obtained by a measurement performed before said most recent measurement, said respective measurement performed by said transmittance measurement unit;

an exposure amount setting unit connected with said transmittance measurement unit to set an exposure amount control target value in accordance with said measured transmittance of said optical system; and

an exposure amount control system connected with said exposure amount setting unit to control an exposure amount based on said set exposure amount control target value;

wherein

said transmittance measurement unit measures a transmittance of said optical system at said set time interval for transmittance measurement.

Claim 30 (Original): An exposure apparatus according to Claim 29, wherein two sequential measurements of transmittance by said transmittance measurement unit are performed prior to starting of exposure.

Claim 31 (Original): An exposure apparatus according to Claim 29, wherein two sequential measurements of transmittance by said transmittance measurement unit are performed after starting of exposure.

Claim 32 (Previously Presented): An exposure apparatus according to Claim 29, further comprising:

a first sensor to photodetect a part of said exposure light, said first sensor being arranged in the optical path of a part of said exposure light branched by said branch optical system, and

a second sensor arranged to be substantially flush with said substrate to photodetect said exposure light passing through said optical system; wherein said transmittance measurement unit includes

a control unit to obtain a transmittance of said optical system, based on an output signal which said first sensor outputs by photodetecting a part of said exposure light and an output signal which said second sensor outputs by photodetecting said exposure light passing through said optical system.

Claim 33 (Original): An exposure apparatus according to Claim 32, wherein said exposure amount control system controls said exposure amount based on said exposure amount control target value and said output from said first optical sensor when transferring said pattern onto said substrate.

Claim 34 (Previously Presented): An exposure apparatus according to Claim 24, wherein said control unit sets a time interval for measurement of said transmittance measurement unit in accordance with a transmittance of said mask on which said pattern is formed.

Claim 35 (Previously Presented): An exposure apparatus according to Claim 24, wherein said control unit sets a time interval for measurement of said transmittance measurement unit in accordance with one of a minimum line width and a permissible exposure amount error.

Claims 36-39 (Cancelled).

Claim 40 (Original): An exposure apparatus according to Claim 24, further comprising:

a mask stage disposed between said illumination optical system and said projection optical system to hold said mask on which said pattern is formed; and

a substrate stage disposed in an image plane side of said projection optical system to hold said substrate, wherein

said optical system includes

an illumination optical system disposed in an optical path of said exposure light to illuminate said mask on which said pattern is formed with said exposure light, and

a projection optical system disposed in said optical path of said exposure light to project said exposure light which exits from said mask onto said substrate.

Claim 41 (Original): An exposure apparatus according to Claim 40, further comprising:

a driving unit connected with said mask stage and said substrate to synchronously move said mask stage and said substrate stage in a linear direction perpendicular to an optical axis of said projection optical system.

Claim 42 (Currently Amended): An exposure apparatus to transfer a pattern illuminated with exposure light from a light source onto a substrate, said exposure apparatus comprising:

a branch optical system arranged in an optical path of said exposure light to branch a part of said exposure light;

an optical system arranged between said branch optical system and said substrate;

a first sensor arranged in the optical path of a part of said branched exposure light to photodetect a part of said exposure light;

a second sensor arranged substantially flush with said substrate to photodetect said exposure light passing through said optical system;

a measurement unit connected with said first sensor and said second sensor to measure a variation in an amount of exposure light passing through said optical system at a predetermined time interval, based on an output signal from said first sensor and an output signal from said second sensor; and

a control unit connected with said measurement unit to change said time interval ~~in accordance with in consideration of a transmittance of said optical system that changes depending on~~ an exposure condition for transferring said pattern onto said substrate.

Claim 43 (Cancelled).

Claim 44 (Currently Amended): An exposure apparatus to transfer a pattern illuminated with exposure light from a light source onto a substrate through an optical system, said exposure apparatus comprising:

a measurement unit to measure ~~a variation in~~ an amount of exposure light passing through said optical system; and

a control unit connected with said measurement unit to ~~obtain a time interval for measurement for measuring an amount of said exposure light passing through said optical system in third and succeeding measurements in accordance with a comparison result of an amount obtained by a first measurement performed by said measurement unit and an amount obtained by a second measurement performed by said measurement unit change a time interval of a measurement performed by said measurement unit, in accordance with a comparison result of a variation of a first measurement of said light amount and a variation of a second measurement of said light amount.~~

Claim 45 (Original): An exposure apparatus to transfer a pattern illuminated with exposure light from a light source onto a substrate through an optical system, said exposure apparatus comprising:

 a unit which communicates with said optical system to self-clean said optical system by irradiating said optical system with said exposure light in a predetermined condition before starting of exposure;

 a calculation unit connected with said unit to determine a transmittance time-varying prediction function of said optical system in consideration of said predetermined condition; and

 an exposure amount setting unit connected with said calculation unit to set an exposure amount control target value based on said determined transmittance time-varying prediction function.

Claim 46 (Currently Amended): An exposure apparatus to transfer a pattern illuminated with exposure light from a light source onto a substrate through an optical system, said exposure apparatus comprising:

 a measurement unit to measure an amount of exposure light passing through said optical system and reaching onto said substrate at a predetermined time interval;

 a selection unit to select any exposure condition among a plurality of exposure conditions for transferring said pattern onto said substrate; and

 a control unit to change said time interval of said measurement unit ~~in accordance~~ with in consideration of a transmittance of said optical system that changes depending on said any exposure condition selected by said selection unit.

Claims 47-48 (Cancelled).

Claim 49 (Original): A device manufacturing method including a lithographic process, wherein exposure is performed in said lithographic process by using said exposure method according to Claim 1.

Claim 50 (Original): A device manufacturing method including a lithographic process, wherein exposure is performed in said lithographic process by using said exposure method according to Claim 14.

Claim 51 (Original): A device manufacturing method including a lithographic process, wherein exposure is performed in said lithographic process by using said exposure method according to Claim 16.

Claim 52 (Original): A device manufacturing method including a lithographic process, wherein exposure is performed in said lithographic process by using said exposure method according to Claim 19.

Claim 53 (Cancelled).

Claim 54 (Original): A device manufactured by using said exposure apparatus according to Claim 24.

Claim 55 (Original): A device manufactured by using said exposure apparatus according to Claim 42.

Claim 56 (Original): A device manufactured by using said exposure apparatus according to Claim 44.

Claim 57 (Original): A device manufactured by using said exposure apparatus according to Claim 45.

Claim 58 (Original): A device manufactured by using said exposure apparatus according to Claim 46.

Claim 59 (Previously Presented): An exposure method according to Claim 1, wherein a part of said exposure light is branched away from said exposure light by a branch optical system arranged in an optical path of said exposure light, and said optical system includes a plurality of optical elements arranged between said branch optical system and said substrate.

Claim 60 (Currently Amended): An exposure method according to ~~Claim 6~~ Claim 1, wherein

~~a variation amount a change of a transmittance of said optical system is calculated based on a transmittance of said optical system measured before said exposure condition is set, and a transmittance of said optical system measured after said exposure condition is set obtained by a most recent measurement and a transmittance obtained by a measurement performed before said most recent measurement.~~

Claim 61 (Previously Presented): An exposure apparatus according to Claim 24, further comprising:

a first sensor arranged in an optical path of a part of said exposure light which is branched by said branch optical system to photodetect a part of said exposure light, and a second sensor arranged substantially flush with said substrate to photodetect said exposure light passing through said optical system; wherein

said transmittance measurement unit comprises

a control unit which obtains a transmittance of said optical system, based on an output signal sent from said first sensor when photodetecting a part of said exposure light and an output signal sent from said second sensor when photodetecting said exposure light passing through said optical system.

Claim 62 (Previously Presented): An exposure apparatus according to Claim 45, wherein said predetermined conditions include an irradiation time of said exposure light on said optical system, an exposure light intensity, and an irradiation amount.

Claim 63 (Previously Presented): An exposure method according to Claim 19, wherein said time-varying function is a function expressed by

$$T = a \cdot \exp \left(\sum_{i=1}^k b_i t \right)$$

in which T is said transmittance of said optical system, "a" is a parameter representing a rate of change in said transmittance, and b_i is a parameter dependent on each exposure condition including an illumination condition.

Claim 64 (Previously Presented): An exposure method according to Claim 19, further comprising prior to said prediction function determining:

measuring a period of time in which said exposure apparatus most recently stops operation;

measuring an irradiation time of exposure light on said optical system in a self-cleaning operation which is performed after said exposure apparatus most recently stops operation;

measuring an exposure light intensity; and

measuring an irradiation amount.

Claim 65 (Previously Presented): An exposure method according to Claim 19, wherein environmental conditions for said optical system are measured at a predetermined time interval, and said environmental conditions are considered when transmittance time-varying prediction function is determined.

Claim 66 (Previously Presented): An exposure method according to Claim 19, further comprising:

measuring a transmittance of said optical system at a predetermined time interval, and corrects said transmittance time-varying prediction function each time a transmittance measurement is performed.

Claim 67 (Previously Presented): An exposure method according to Claim 66, wherein said predetermined time interval of said measuring said transmittance is determined in respect to a relationship with a required exposure precision.

Claim 68 (Previously Presented): An exposure method according to Claim 66, wherein said time interval of said measuring said transmittance is short when a rate of change in said transmittance of said optical system is large, and long when said rate of change in said transmittance of said optical system is small.

Claim 69 (Previously Presented): An exposure method according to Claim 59, wherein said optical system includes a part of an illumination optical system to illuminate said mask and a projection optical system to transfer said pattern onto said substrate.

Claim 70 (Previously Presented): An exposure method according to Claim 69, wherein a transmittance of said optical system is a ratio between a photodetection result of a part of said exposure light photodetected between said light source and said mask, and a photodetection result of said exposure light passing through said optical system.

Claim 71 (Previously Presented): An exposure method according to Claim 70, wherein said time interval for measurement is determined by the number of said substrates onto which said pattern can be transferred.

Claim 72 (Previously Presented): An exposure method according to Claim 60, wherein a transmittance of said optical system is a ratio between a photodetection result of a part of said exposure light photodetected between said light source and said mask, and a photodetection result of said exposure light passing through said optical system.

Claim 73 (Previously Presented): An exposure method according to Claim 14, wherein said optical system includes a part of an illumination optical system to illuminate said mask and a projection optical system to transfer said pattern onto said substrate.

Claim 74 (Previously Presented): An exposure method according to Claim 14, wherein a transmittance of said optical system is a ratio between a photodetection result of a part of said exposure light photodetected between said light source and said mask, and a photodetection result of said exposure light passing through said optical system.

Claim 75 (Previously Presented): An exposure method according to Claim 14, wherein said time intervals that are different from one another are determined by the number of said substrates onto which said pattern can be transferred.

Claim 76 (Previously Presented): An exposure method according to Claim 16, wherein said time interval for measurement is determined by the number of said substrates onto which said pattern can be transferred.

Claim 77 (Previously Presented): An exposure method according to Claim 16, wherein said optical system includes a part of an illumination optical system to illuminate said mask and a projection optical system to transfer said pattern onto said substrate.

Claim 78 (Previously Presented): An exposure method according to Claim 77, wherein a variation of the light amount is calculated based on a photodetection result of a part of said exposure light photodetected between said light source and said mask and a photodetection result of said exposure light passing through said optical system.

Claim 79 (Previously Presented): An exposure apparatus according to Claim 61, wherein a transmittance of said optical system is a ratio between an output signal of said first sensor and an output signal of said second sensor.

Claim 80 (Previously Presented): An exposure apparatus according to Claim 24, wherein said exposure condition includes an illumination condition to illuminate said mask, and the illumination condition includes one of a ring-shaped illumination and a modified illumination.

Claim 81 (Previously Presented): An exposure apparatus according to Claim 42, wherein said measurement unit measures a variation in the amount of said exposure light based on a ratio between an output signal from said first sensor and an output signal from said second sensor.

Claim 82 (Previously Presented): An exposure apparatus according to Claim 42, wherein said exposure condition includes at least one of an illumination condition to illuminate a mask on which said pattern is formed, a transmittance of the mask on which said pattern is formed, a minimum line width of said pattern, and a permissible exposure amount error.

Claim 83 (Previously Presented): An exposure apparatus according to Claim 45, said time-varying prediction function has a period of time in which the operation of said apparatus is stopped as a parameter.

Claim 84 (Previously Presented): An exposure apparatus according to Claim 45, wherein said predetermined condition includes an irradiation time of said exposure light on said optical system, an exposure light intensity and an irradiation amount.

Claim 85 (Previously Presented): An exposure apparatus according to Claim 46, said exposure condition includes at least one of an illumination condition to illuminate a mask on which said pattern is formed, a transmittance of the mask on which said pattern is formed, a minimum line width of said pattern, and a permissible exposure amount error.